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I also certify that the attached copy of the request for grant of a Patent (Form 1/77) bears an amendment, effected by this office, following a request by the applicant and agreed to by the Comptroller-General.

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Dated 13 August 2003

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1/77

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P01/7700 0.00-0218060.2

THE PATENT OFFICE
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- 3 AUG 2002
NEWPORT

Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

The Patent Office

Cardiff Road
Newport
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1. Your reference

A108.007

2. Patent application number
(The Patent Office will fill in this part)

0218060.2

- 3 AUG 2002

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

Alstom (Switzerland) Ltd
Brown Boveri Strasse 7
CH5401 Baden
Switzerland

Patents ADP number *(if you know it)* 84362890 01

If the applicant is a corporate body, give the country/state of its incorporation

Switzerland

4. Title of the invention

Sealing arrangements

5. Name of your agent *(if you have one)*

~~SERJEANTS~~

LAURENCE PETER DARGAVEL
ALSTOM INT. PROP.
ALSTOM LTD
P.O.BOX 30
LICHFIELD ROAD.
STAFFORD
ST17 4LN

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

~~25 The Crescent~~
~~King Street~~
~~Leicester~~
~~LE1 6RX~~

Patents ADP number *(if you know it)*

1461001

5/1/77
JAM 16.6.03

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*

a) any applicant named in part 3 is not an inventor, or
b) there is an inventor who is not named as an applicant, or
c) any named applicant is a corporate body.
See note (d))

Yes

Patents Form 1/77

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	
Description	6
Claim(s)	2
Abstract	1
Drawing(s)	3 + 3

10. If you are also filing any of the following, state how many against each item.

Priority documents	
Translations of priority documents	
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	1
Request for preliminary examination and search *(Patents Form 9/77)*	
Request for substantive examination *(Patents Form 10/77)*	
Any other documents *(please specify)*	

11. I/We request the grant of a patent on the basis of this application.

Signature Serjeants. Date
SERJEANTS 02 August 2002

12. Name and daytime telephone number of person to contact in the United Kingdom

Darran Thacker
0116 233 2626

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d) If you have answered 'Yes' Patents Form 7/77 will need to be filed.

e) Once you have filled in the form you must remember to sign and date it.

f) For details of the fee and ways to pay please contact the Patent Office.

TITLE

Sealing arrangements

DESCRIPTION

Technical Field

The present invention relates to sealing arrangements, and in particular to sealing arrangements for improving the seal between adjacent casing segments of a gas turbine engine.

Background Art

The gas turbine industry is continuously striving to reduce leakage between different areas of the gas turbine engine. One place where leakage typically occurs is past the tips of the turbine or compressor blade where a small gap (typically about 1 mm) must be maintained between the blade and the casing. This leakage can be reduced in a variety of ways but a common solution is to mount a sacrificial collar of abradable material on the radially inner surface of the casing. One or more sealing fences are then formed on the tip of the blade which can contact the abradable material and wear it away as the blade expands or moves during use. This ensures that the clearance between the tip of the blade and the casing can be maintained at an absolute minimum.

To accommodate different thermal expansion rates it is necessary to divide the casing around the tips of the turbine or compressor blade into a number of casing segments. The casing segments have a simple construction and are butted up against each other such that adjacent segments have a common joint that runs parallel to the longitudinal axis of the turbine or compressor. The casing segments are held in position by grooves formed in a radially outer portion of the gas turbine engine housing.

The abutting faces of each segment have a groove for receiving a strip seal. The strip seal extends across the common joint and also helps to keep the adjacent segments together. Unfortunately, the strip seals are not particularly efficient and there is a

significant amount of radial and axial leakage through the gaps between the casing segments.

It is therefore a purpose of the present invention to provide an alternative sealing arrangement that is more efficient than the strip seal.

Summary of the Invention

The present invention provides a sealing arrangement for sealing around a turbine or compressor including at least one casing segment having a pair of faces for abutting with circumferentially adjacent casing segments, wherein at least a part of each face is forced into contact with an adjacent casing segment by rotation of the casing segment about a pivot to form a seal.

The pair of faces can be stepped in the circumferential direction. By this is meant that the segment has at least two planar faces orientated generally parallel to the longitudinal axis of the turbine or compressor and at least one planar face orientated generally perpendicular to the longitudinal axis of the turbine or compressor to form one or more rebates.

The tip of the turbine or compressor blade is preferably provided with at least one sealing fence to reduce the axial leakage between the blade and the sealing arrangement. If only a single fence is provided then the face of the casing segment preferably has two planar faces orientated generally parallel to the longitudinal axis of the turbine or compressor and one planar face orientated generally perpendicular to the longitudinal axis of the turbine or compressor to form a singe rebate. The planar face orientated generally perpendicular to the longitudinal axis of the turbine or compressor is preferably axially aligned with the fence so that the casing segment provides a circumferential overlap along the line of the fence.

If the tip of the turbine or compressor blade is provided with two sealing fences then the face of the casing segment preferably has three planar faces orientated generally parallel to the longitudinal axis of the turbine or compressor and two planar faces

orientated generally perpendicular to the longitudinal axis of the turbine or compressor to form a double rebate. The planar faces orientated generally perpendicular to the longitudinal axis of the turbine or compressor are preferably axially aligned with the respective fences so that the casing segment provides a circumferential overlap along the line of each fence. It will be readily appreciated that further fences and rebates can be provided in the same manner.

Alternatively, the pair of faces can be oblique with respect to the circumferential direction. By this is meant that the face is generally planar and the casing segment, if viewed radially, is generally shaped like a parallelogram. The faces can also be arcuate. For the efficient operation of the sealing arrangement it is only important that the common joint between two adjacent casing segments does not run parallel to the longitudinal axis of the turbine or compressor blade.

A radially inner surface of the casing segment is preferably stepped in the radial direction to accommodate the shape of the tip of the turbine or compressor blade.

A radially outer surface of the casing segment preferably further includes a pin about which the casing segment can pivot. The pin is preferably positioned such that a pressure differential across the casing segment causes the casing segment to rotate about the pin. Alternatively, the casing segment can be made to rotate about the pin by any other suitable means. This rotation forces part of each face into contact with an adjacent casing segment and provides a better seal than if the adjacent casing segments are simply butted up against each other. For example, if the face is stepped then this rotation forces the planar face or faces orientated generally perpendicular to the longitudinal axis of the turbine or compressor into contact with an adjacent casing segment. Because the adjacent casing segments are rotating in different directions the seal between the planar face or faces is particularly efficient and greatly reduces axial leakage.

To reduce radial leakage the sealing arrangement preferably includes a sealing plate in contact with the radially outer surface of the casing segment and extending

circumferentially over the common joint between a pair of adjacent casing segments. The sealing plate preferably includes a hole for receiving the pin provided on the radially outer surface of the casing segment.

Drawings

Figure 1 is a cross sectional view of a conventional sealing arrangement;

Figure 2 is a cross sectional view of a sealing arrangement according to the present invention;

Figure 3 is a top view showing a pair of casing segments of Figure 2;

Figure 4 is a schematic view showing the casing segment and cover plate of Figure 2; and

Figure 5 is a top view showing a pair of alternative casing segments.

A conventional sealing arrangement for sealing around a turbine blade 2 is shown in Figure 1. The sealing arrangement includes a plurality of circumferentially arranged casing segments 4 which are received in annular grooves 6 and 8 in a radially outer portion of the gas turbine engine housing 10.

The tip 12 of the turbine blade 2 is formed with a pair of sealing fences 14. The fences 14 are axially aligned with two annular strips of abradable material 16 which accommodate expansion of the blade 2 during operation of the gas turbine engine and maintain a minimum clearance between the tip 12 of the blade and the casing segments 4.

The casing segments 4 are butted up against each other such that adjacent segments have a common joint (not shown) that runs parallel to the longitudinal axis of the turbine. The abutting side faces 18 of the casing segments 4 are provided with an arcuate groove into which a metal strip seal 20 is inserted. The strip seals 20 span the common joint between the adjacent casing segments 4 to prevent leakage. They also help to join the adjacent casing segments 4 together.

Figures 2 to 4 show a sealing arrangement in accordance with a first embodiment of the present invention. A plurality of casing segments 22 and 22' are circumferentially arranged around a turbine blade 2 and provide a seal between a low-pressure region (L.P.) of the gas turbine engine and a high-pressure region (H.P.) of the gas turbine engine. The tip 12 of the turbine blade 2 is provided with a pair of sealing fences 14.

The casing segments 22 and 22' have a stepped radially inner surface 24 and a planar radially outer surface 26. The casing segments 22 and 22' are butted up against each other and have side faces 28 that are also stepped as shown in Figures 3 and 4. The casing segments 22 and 22' are manufactured to provide a circumferential overlap at the nominal axial positions (A and B) of the fences 14 and have two planar faces 30 and 32 that lie along the line of the fences 14.

The radially outer surface 26 has a mounting pin 34 which prevents the casing segments 22 and 22' from moving circumferentially around the turbine. The pin 34 is positioned off-centre such that the gas pressure GP acting on the high-pressure side of the casing segments 22 and 22' causes the casing segments to pivot slightly in the directions shown by the block arrows in Figure 3. This pivoting movement forces the two planar faces 30 and 32 of the first casing segment 22 into close contact with the two planar faces 30' and 32' of the second casing segment 22' to form a seal and reduce axial leakage through the common joint between the segments.

To reduce radial leakage a plurality of sealing plates 36 are provided on top of the casing segments 22 as shown in Figures 2 and 3. The sealing plates 36 are provided with a hole 38 to receive the mounting pin 34 and completely cover the common joint between the segments. Cooling air pressure AP above the casing segments 22 maintains the sealing plates 36 in close contact with the segments.

Figure 5 illustrates an alternative pair of casing segments 40 and 40'. The casing segments 40 and 40' are butted up against each other and have side faces 42 that are oblique with respect to the circumferential direction. In other respects the casing

segments 40 and 40' are the same as the casing segments 22 and 22' shown in Figures 2 to 4 and pivot about a mounting pin 44 to produce a seal in a similar manner.

CLAIMS

1. A sealing arrangement for sealing around a turbine or compressor including at least one pivotally mounted casing segment having a pair of faces for abutting with circumferentially adjacent casing segments, wherein at least a part of each face is forced into contact with an adjacent casing segment by rotation of the casing segment about the pivot to form a seal.

2. A sealing arrangement according to claim 1, wherein each of the pair of faces is stepped in the circumferential direction.

3. A sealing arrangement according to claim 1, wherein each of the pair of faces is oblique with respect to the circumferential direction.

4. A sealing arrangement according to any preceding claim, wherein a radially inner surface of the casing segment is stepped in the radial direction.

5. A sealing arrangement according to any preceding claim, wherein a radially outer surface of the casing segment further includes a pin about which the casing segment can pivot.

6. A sealing arrangement according to claim 5, wherein the pin is positioned such that a pressure differential across the casing segment causes the casing segment to rotate about the pin.

7. A sealing arrangement according to claim 5 or claim 6, further including a sealing plate in contact with the radially outer surface of the casing segment and extending circumferentially over the common joint between a pair of adjacent casing segments.

8. A sealing arrangement according to claim 7, wherein the sealing plate includes a hole for receiving the pin.

9. A sealing arrangement as herein described and with reference to Figures 2 to 4.

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TITLE

Sealing arrangements

(Figure 2)

5

ABSTRACT

The present invention provides a sealing arrangement for sealing around a turbine or compressor blade (2). The arrangement includes at least one casing segment (22) having a pair of faces (28) for abutting with circumferentially adjacent casing 10 segments. At least part of each face (28) is forced into contact with an adjacent casing segment by rotation of the casing segment (22) about a mounting pin (34) to form a seal. To reduce radial leakage a sealing plate (36) is provided.

15

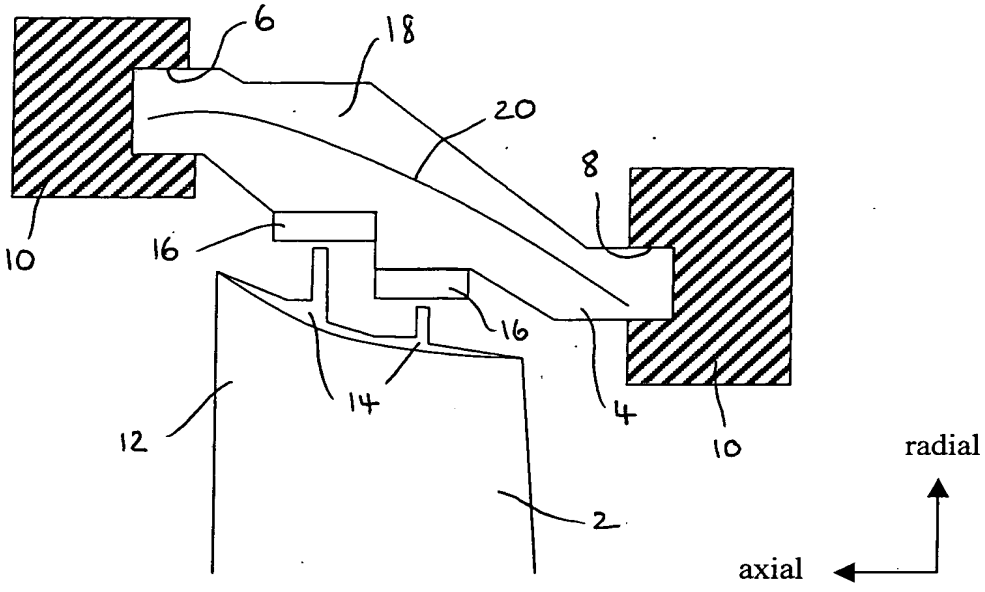

Figure 1

PRIOR ART

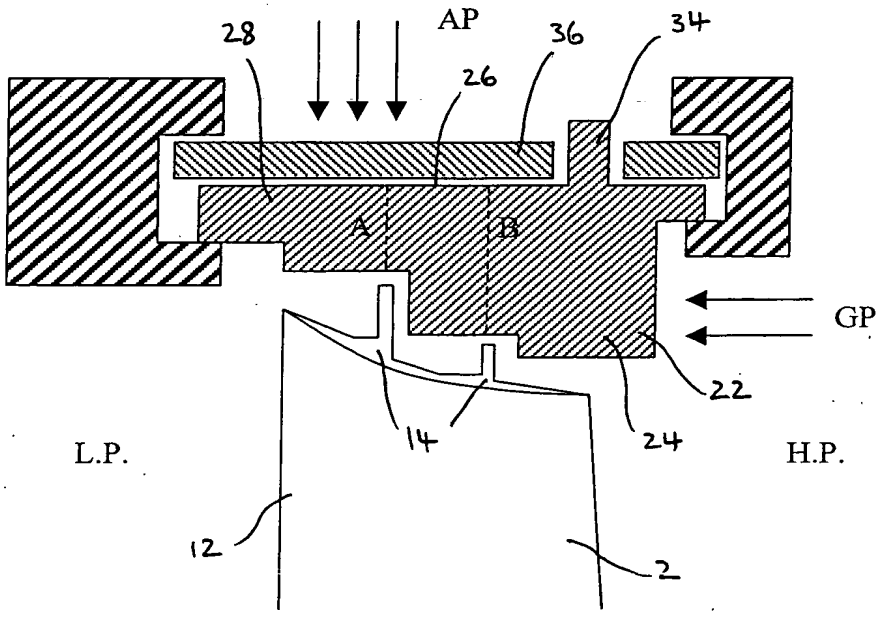

Figure 2

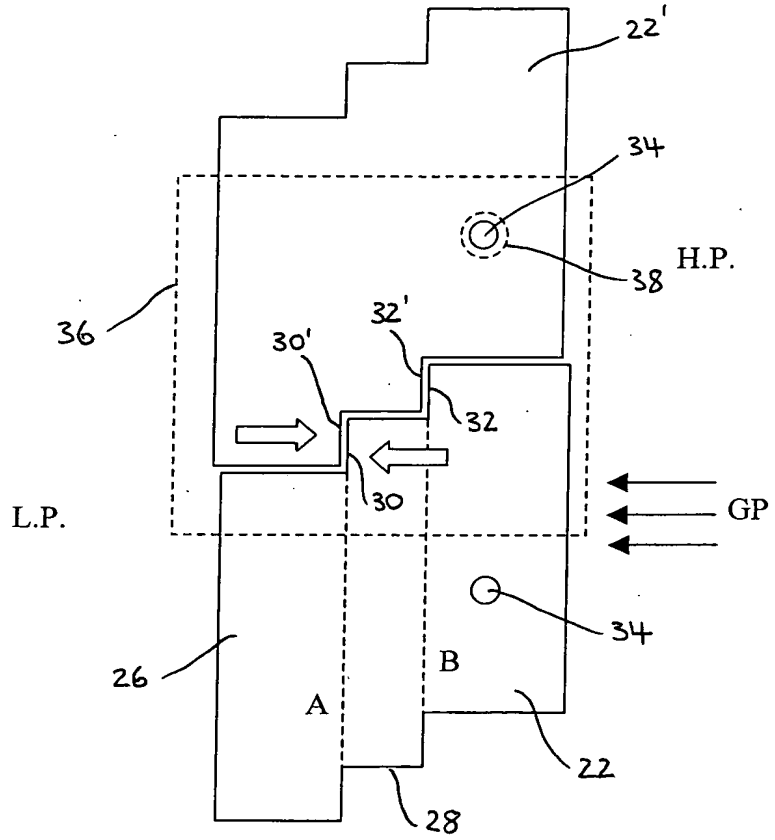

Figure 3

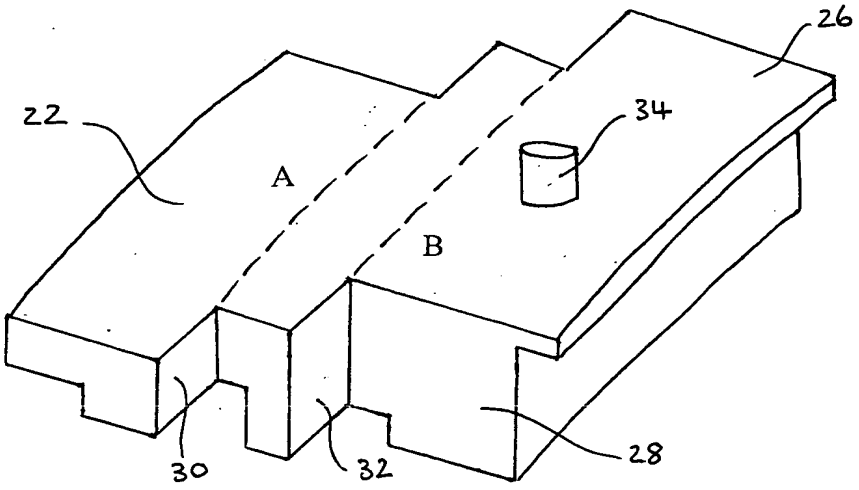

Figure 4

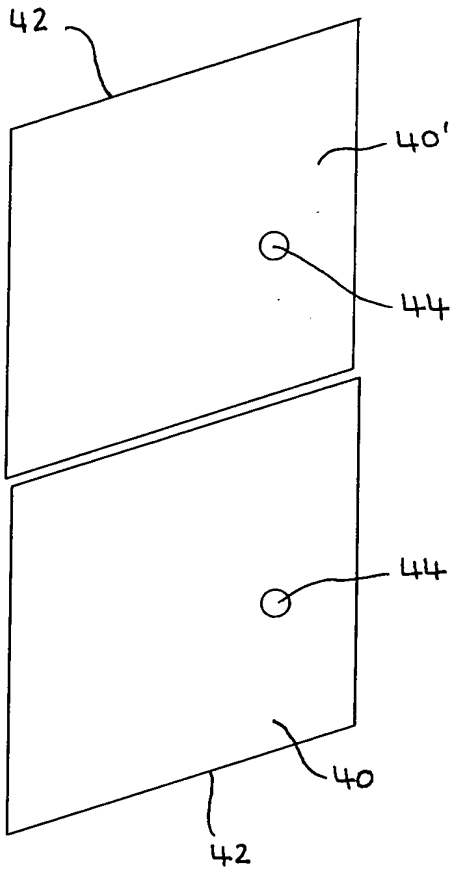

Figure 5